CLAIM OR CLAIMS

WHAT IS CLAIMED IS:

1. A method of non-invasive estimation of round trip time between a sender and a receiver in a packet-oriented acknowledge-based transmission system using a probe to monitor signals transmitted between the sender and receiver during a connection comprising the steps of:

presetting a number of acknowledgments in a sequence of acknowledgments received by the probe within an acknowledgment time interval for analysis;

comparing timestamps of the preset number of acknowledgments with timestamps of packets received by the probe during a time period before the sequence of acknowledgments to determine an estimated value for a round trip time between the probe and the receiver;

comparing the timestamps for the preset number of acknowledgments with timestamps of packets received by the probe during a time period after the sequence of acknowledgments to determine an estimated value for a round trip time between the probe and the sender; and

adding the estimated values to estimate the round trip time between the sender and the receiver.

2. The method according to claim 1 wherein in the first comparing step the time period comprises a point in time of an earliest one of the preset number of acknowledgments minus a maximum round trip time.

3. The method according to claim 1 wherein in the second comparing step the time period comprises a point in time of an earliest one of the preset number of acknowledgments plus the acknowledgment time interval plus a maximum round trip time.

4. The method according to claim 2 wherein in the second comparing step the time period comprises the point in time of the earliest one of the preset number of acknowledgments plus the acknowledgment time interval plus the maximum round trip time.

5. The method according to any of claims 1-4 wherein the acknowledgment time interval comprises n discrete points in time that are spaced apart by a resolution time interval and wherein each comparing step further comprises the steps of:

finding one of the packets that is nearest in time to one of the preset number of acknowledgments;

calculating a difference in time between the one of the preset number of acknowledgments and the one packet;

iterating the finding and calculating steps for each of the preset number of acknowledgments to provide the difference in time for each of the preset number of acknowledgments;

determining a mean difference in time from the differences in time;

moving the timestamps of the preset number of acknowledgments by the resolution step;

repeating the finding, calculating, iterating, determining and moving steps until the moved timestamps reach an end of the acknowledgment time interval; and

searching for a minimum mean difference in time from among the mean differences in time.

6. The method according to claim 5 wherein the estimated value comprises an iteration number corresponding to the minimum mean difference in time multiplied by the resolution step.

7. The method according to claim 6 further comprising the step of determining sequence numbers of the packets and sequence numbers of the preset number of acknowledgments.

8. The method according to claim 7 further comprising the steps of:

finding one of the packets that is nearest in time to one of the preset number of acknowledgments;

calculating a difference in sequence numbers between the one of the preset number of acknowledgments and the sequence number of the one packet;

iterating the finding and calculating steps for each of the preset number of acknowledgments to provide the difference in sequence number for each of the preset number of acknowledgments;

determining a mean difference in sequence numbers;

moving the timestamps of the preset number of acknowledgments by the resolution step;

repeating the finding, calculating, iterating, determining and moving steps until the moved timestamps reach the end of the acknowledgment time interval; and

searching for a minimum mean difference in sequence numbers from among the means differences in sequence numbers.

9. The method according to claim 8 wherein an estimated sliding window is used in the difference in sequence numbers calculating step.

10. The method according to claim 9 wherein a lower limit for the estimated sliding window comprises an apparent window where the apparent window corresponds to a number of packets for which an acknowledgment has not yet been received by the probe.

11. The method according to claim 9 wherein a lower limit for the estimated sliding window comprises one if a packet loss is detected.

12. The method according to claim 9 wherein the estimated sliding window in the case of a packet loss comprises cwnd(t+1) = cwnd(t)/2 where cwnd(t) is the estimated sliding window at a given time t.

13. The method according to claim 12 wherein the estimated sliding window in the case of receiving acknowledgments with new sequence numbers comprises cwnd(t+1) = cwnd(t) + 1/cwnd(t).

14. The method according to claim 13 wherein the estimated sliding window comprises an advertized window in the case where cwnd(t+1) is greater than the advertized window, the advertized window being a preset configuration parameter.

15. The method according to claim 14 wherein at the beginning of the connection the estimated sliding window is doubled for each acknowledgment received by the probe.

16. The method according to claim 14 wherein the estimated sliding window is doubled for each acknowledgment received by the probe until a packet loss is detected.

17. The method according to claim 8 further comprising for the time periods both before and after the sequence of acknowledgments the steps of:

determining a minima from the mean differences in sequence numbers;

determining a minima from the mean differences in time that is near the minima from the mean difference in sequence numbers; and

determining a point in time before and after the sequence of

acknowledgments where the minimum of the mean differences in time is nearest to the minimum of the mean differences in sequence numbers.

18. The method according to claim 17 wherein the round trip times between the probe and sender and between the probe and receiver are determined by subtracting the point in time of the earliest one of the preset number of acknowledgments from the point in time after the point in time of the earliest one of the preset number of acknowledgments and by subtracting the point in time before the point in time of the earliest one of the preset number of acknowledgments from the point in time of the earliest one of the preset number of acknowledgments respectively.